IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.: 10/709,420

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Applicant: Youssef Hamidieh et. al.

Group Art Unit: 2856

Examiner: Chapman Jr., John E.

Title: Structurally Tuned Vibration Based Component Checking System and Method

Attorney Docket: 81098863/FMC 1747 PUS

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT AND RESPONSE TO OFFICE ACTION

Sir:

This is in response to the Examiner's Office Action mailed November 25, 2005 to which a response is due by February 27, 2006. Applicants respectfully request reconsideration of the Examiner's rejections and/or objections in view of the remarks set forth below:

Amendments to the Claims are reflected in the listing of claims that begins on Page 2 of this paper.

Remarks/Arguments begin on Page 13 of this paper.

LISTING OF THE CLAIMS

1. (Currently Amended) A method for detecting anomalies in a component of an assembly prior to the component being installed in the assembly, the component being movable at one or more speeds in the assembly, the method comprising:

configuring a component checking system, including at least one checking system sensor, capable of operating the component at one or more predetermined speeds;

determining a speed of operation for the component in the checking system, chosen from the one or more predetermined speeds;

determining at least one anomaly frequency of the component in the checking system, the at least one anomaly frequency of the component in the checking system being a function of the speed of operation of the component in the checking system;

configuring at least a portion of the checking system <u>using the at least one anomaly frequency of the component in the checking system</u> to have at least one modal frequency within a predetermined frequency range of the checking system, the predetermined frequency range of the checking system including the at least one anomaly frequency of the component in the checking system;

configuring at least a portion of the checking system to have modal characteristics such that discrimination for the component in the checking system is within a predetermined range based on discrimination for the component in the assembly, the discrimination for the component in the checking system being determined by comparing an amplitude response of the checking system using a component having at least one anomaly and an amplitude response of the checking

system using a component having substantially no anomalies, the modal characteristics and the amplitude responses of the checking system being determined using the at least one checking system sensor;

operating the component in the checking system; and

measuring values of a response parameter of the checking system while the component is being operated in the checking system, thereby facilitating detection of anomalies in the component.

2. (Original) The method of claim 1, further comprising:

determining at least one modal frequency of the assembly using at least one assembly sensor;

determining at least one anomaly frequency of the component in the assembly, the at least one anomaly frequency of the component in the assembly being a function of a speed of the component at which at least one anomaly is detectable when the component is operating in the assembly;

determining whether the at least one anomaly frequency of the component in the assembly is within a predetermined frequency range of the assembly, the predetermined frequency range of the assembly including the at least one modal frequency of the assembly; and

determining a location of the at least one anomaly frequency with respect to the at least one modal frequency of the assembly.

3. (Original) The method of claim 2, further comprising:

using the at least one assembly sensor to determine a first amplitude response of the assembly, with the assembly including a component having at least one anomaly; and

using the at least one assembly sensor to determine a second amplitude response of the assembly, with the assembly including a component having substantially no anomalies, and

wherein, determining the discrimination for the component in the assembly includes comparing the first and second amplitude responses of the assembly.

4. (Original) The method of claim 1, further comprising comparing at least one of the measured values of the response parameter to a predetermined value, thereby further facilitating detection of anomalies in the component.

5. (Original) The method of claim 1, wherein the response parameter of the checking system is vibration, and the vibration values are measured using the at least one checking system sensor.

6. (Original) The method of claim 5, wherein measuring the vibration values includes at least one of measuring acceleration, velocity, displacement, and acoustic characteristics, the measurements occurring over a bandwidth that includes the predetermined frequency range of the checking system.

7. (Original) The method of claim 5, further comprising: transforming at least some of the measured values from a time domain to a frequency domain; and

comparing at least one of the transformed values to a predetermined value, thereby further facilitating detection of anomalies in the component.

8. (Original) The method of claim 1, further comprising engaging the component in the checking system with a mating component, the engagement in the checking system corresponding to an engagement of the component and a mating component in the assembly.

9. (Original) A method for detecting anomalies in a selected gear for a vehicle transmission prior to the selected gear being installed in the transmission, the method comprising:

determining at least one modal frequency of the transmission using at least one sensor on a housing of the transmission;

determining a transmission gear mesh frequency as a function of the number of teeth on the selected gear and a speed of rotation of the selected gear in the transmission;

determining whether the transmission gear mesh frequency is within a predetermined transmission frequency range, the predetermined transmission frequency range including the at least one modal frequency of the transmission;

determining a location of the transmission gear mesh frequency with respect to the at least one modal frequency of the transmission;

determining whether at least one harmonic frequency of the transmission gear mesh frequency is within the predetermined transmission frequency range;

determining a location of the at least one harmonic frequency of the transmission gear mesh frequency with respect to the at least one modal frequency of the transmission;

using the at least one sensor on the transmission housing to determine a first amplitude response of the transmission, the transmission including a gear having at least one anomaly;

using the at least one sensor on the transmission housing to determine a second amplitude response of the transmission, the transmission including a gear having substantially no anomalies;

determining a discrimination for the selected gear in the transmission by comparing the first and second amplitude responses;

configuring a gear checking system, including at least one checking system sensor, capable of rotating the selected gear at one or more predetermined speeds;

determining a speed of rotation for the selected gear in the checking system, chosen from the one or more predetermined speeds;

determining a checking system gear mesh frequency as a function of the number of teeth on the selected gear and the speed of rotation of the selected gear in the checking system;

determining at least one harmonic frequency of the checking system gear mesh frequency;

configuring at least a portion of the checking system to have at least one modal frequency within a predetermined frequency range of the checking system, the predetermined frequency range of the checking system including the checking system

gear mesh frequency and the at least one harmonic frequency of the checking system gear mesh frequency;

further configuring at least a portion of the checking system to have modal characteristics such that discrimination for the selected gear in the checking system is within a predetermined range based on the discrimination for the component in the transmission, the discrimination for the selected gear in the checking system being determined by comparing an amplitude response of the checking system using a gear having at least one anomaly and an amplitude response of the checking system using a gear having substantially no anomalies, the modal characteristics and the amplitude responses of the checking system being determined using the at least one checking system sensor;

rotating the selected gear in the checking system; and

measuring values of a response parameter of the checking system while the selected gear is being rotated in the checking system, thereby facilitating detection of anomalies in the gear.

10. (Original) The method of claim 9, further comprising applying a torque load to the selected gear while the selected gear is rotated in the gear checking system.

11. (Original) The method of claim 10, further comprising configuring the checking system with a mating gear for mating with the selected gear, and wherein the torque load is applied to the selected gear through the mating gear.

12. (Original) The method of claim 11, wherein the selected gear and the mating gear engage each other with single flank contact.

13. (Original) The method of claim 11, wherein the selected gear drives the mating gear, and the selected gear is rotated at a speed that is less than the speed used to determine the transmission gear mesh frequency.

14. (Original) The method of claim 9, wherein the response parameter is vibration, and the measured values are acceleration values of at least a portion of the checking system measured over time by the at least one checking system sensor.

15. (Original) The method of claim 14, further comprising:

transforming at least some of the measured values from a time domain to a frequency domain; and

comparing at least one of the transformed values to a predetermined value, thereby further facilitating detection of anomalies in the selected gear.

16. (Currently Amended) A structurally tuned vibration based checking system for detecting anomalies in a movable component of an assembly prior to the component being installed in the assembly, the assembly having modal frequencies, the component having at least one assembly anomaly frequency that is a function of a speed of operation of the component in the assembly at which anomalies in the component are detectable, the at least one assembly anomaly frequency is within a predetermined frequency range of the assembly, the checking system comprising:

a first actuator operable to operate the component at one or more predetermined speeds, the component having at least one checking system anomaly frequency that is a function of the speed of operation of the component in the checking system, the at least one checking system anomaly frequency being different than the at least one assembly anomaly frequency;

a structure for supporting the component while the component is being operated by the first actuator, the structure being configured using the at least one checking system anomaly frequency such that at least a portion of the checking system has at least one modal frequency within a predetermined frequency range of the checking system, the predetermined frequency range of the checking system including the at least one checking system anomaly frequency; and

a sensor for measuring values of a response parameter of the checking system while the first actuator operates the component.

17. (Original) The checking system of claim 16, further comprising a second actuator operable to apply a load to the component while the first actuator operates the component.

18. (Original) The checking system of claim 17, further comprising a second component configured to cooperate with the second actuator and the component, and wherein the second actuator applies the load to the component through the second component.

19. (Original) The checking system of claim 18, wherein the component is a vehicle transmission gear, the first actuator is operable to rotate the transmission gear, and the second actuator is operable to apply a torque load to the transmission gear through a mating gear in contact with the transmission gear.

20. (Original) The checking system of claim 19, wherein the transmission gear and the mating gear engage each other with single flank contact.

21. (Original) The checking system of claim 16, wherein the response parameter is vibration and the sensor measures acceleration values of at least a portion of the checking system, thereby facilitating detection of anomalies in the component.

22. (New) A method for detecting anomalies in a component of an assembly prior to the component being installed in the assembly, the component being movable at one or more speeds in the assembly, the method comprising:

configuring a component checking system, including at least one checking system sensor, capable of operating the component at one or more predetermined speeds;

determining a speed of operation for the component in the checking system, chosen from the one or more predetermined speeds;

determining at least one anomaly frequency of the component in the checking system, the at least one anomaly frequency of the component in the checking system being a function of the speed of operation of the component in the checking system;

configuring at least a portion of the checking system to have at least one modal frequency within a predetermined frequency range of the checking system, the predetermined frequency range of the checking system including the at least one anomaly frequency of the component in the checking system;

configuring at least a portion of the checking system to have modal characteristics such that discrimination for the component in the checking system is within a predetermined range based on discrimination for the component in the assembly, the discrimination for the component in the checking system being determined by comparing an amplitude response of the checking system using a component having at least one anomaly and an amplitude response of the checking system using a component having substantially no anomalies, the modal characteristics and the amplitude responses of the checking system being determined using the at least one checking system sensor;

operating the component in the checking system;

measuring values of a response parameter of the checking system while the component is being operated in the checking system, thereby facilitating detection of anomalies in the component;

determining at least one modal frequency of the assembly using at least one assembly sensor;

determining at least one anomaly frequency of the component in the assembly, the at least one anomaly frequency of the component in the assembly being a function of a speed of the component at which at least one anomaly is detectable when the component is operating in the assembly;

determining whether the at least one anomaly frequency of the component in the assembly is within a predetermined frequency range of the assembly, the predetermined frequency range of the assembly including the at least one modal frequency of the assembly; and

determining a location of the at least one anomaly frequency with respect to the at least one modal frequency of the assembly.

23. (New) The method of claim 22, further comprising:

using the at least one assembly sensor to determine a first amplitude response of the assembly, with the assembly including a component having at least one anomaly; and

using the at least one assembly sensor to determine a second amplitude response of the assembly, with the assembly including a component having substantially no anomalies, and

wherein, determining the discrimination for the component in the assembly includes comparing the first and second amplitude responses of the assembly.

REMARKS/ARGUMENTS

Status of the Claims

Claims 1-23 are pending in this application.

Claims 9-15 are allowed

Claims 1, 4-8 and 16-21 are rejected.

Claims 2 and 3 are objected to.

Claims 1 and 16 have been amended.

Claims 22-23 are new.

Support for these amendments can be found throughout the specification, claims and drawings as originally filed.

The examiner has rejected claims 16-18 and 21 under 35 U.S.C. §102(b) as being anticipated by, or in the alternative, under 35 U.S.C. §103(a) as obvious over Pomernacki '023.

United States Patent No. 4,252,023 to Pomernacki discloses a gear testing system used to sense vibrations occurring during operation of the gears. The testing system includes a gear 10 mounted on a spindle 14 contained in a spindle housing 16. Braces 18 located on a base 20 support the spindle housing 16. A gear 12 is mounted on a spindle 24 contained in a spindle housing 26. A drive motor 40 operates to drive the spindle 14 and correspondingly the gear 10 through a pair of pulleys 22, 36 and a drive belt 34. As set forth in the specification "The drive motor 40 is preferably driven at a speed such that the tooth-to-tooth frequency of the teeth 64 of the gear 10 and the teeth 66 of the gear 12 produce a tooth-to-tooth frequency which is substantially the same as a resonant frequency of the resiliently supported spindle housing 26." (Col. 2, ll. 8-13.) Accordingly, Pomernacki '023 controls the speed of the gears 10, 12 as

necessary to reach the resonant frequency of the resiliently supported spindle housing 26.

Claims 16 as amended includes as an element thereof that the structure is configured using the at least one checking system anomaly frequency. Nothing in Pomernacki '023 discloses using a checking system anomaly frequency to configure the structure of the checking system. To the contrary, as set forth above, Pomernacki '023 varies the speed of the respective gears 10, 12 until they produce a tooth-to-tooth frequency substantially the same as a resonant frequency of the spindle support housing 26. No reference is made to adjusting or tuning the checking system based on a checking system anomaly frequency. This element is not disclosed in nor is it taught or suggested by Pomernacki '023. Accordingly, applicants submit that claim 16 and the claims dependent therefrom are allowable as written.

The examiner has rejected claims 1, 4-8, 19 and 20, under 35 U.S.C. §103(a) as unpatentable over Pomernacki '023. With respect to claim 1, claim 1 as amended includes that at least a portion of the checking system is configured using the at least one anomaly frequency of the component in the checking system. As set forth above, this element is not taught or suggested by Pomernacki '023. Accordingly, applicants submit that claim 1 and the claims dependent therefrom are allowable as written.

Applicant has added new claims 22, 23. Claims 22 is claim 2 rewritten in independent form to include the limitations of base claim 1 which the examiner has indicated as being allowable. Claim number 23 is same as claim 3 and is dependent upon claim 22, thus applicants submit that claim 23 is also in condition for allowance.

The Examiner is invited to telephone the applicant's undersigned attorney at (313) 337-1069 if any unresolved matters remain.

Please charge any cost incurred in the filing of this amendment, along with any other costs, to Deposit Account No. 06-1510. If there are insufficient funds in this account, please charge the fees to Deposit Account No. 06-1505.

Respectfully submitted,

Attorney for Applicant(s)

By: ______________________
Raymond L. Coppiellie
Registration No. 33,311
Attorney for Applicants

Dated:

Ford Global Technologies LLC
1 Parklane Blvd., Ste 600E
Dearborn, MI 48126
Phone: (313) 337-1069